Space Weather Technical Forecast

Issued on Monday, 13 February 2023 at 00:35 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance of X-flares (R3 Radio Blackout) with M-flares (R1/R2 Radio Blackouts) likely. Chance of G1/Minor Storm and slight chance of G2/Moderate Storm on Days 1 and 2 (13-14 Feb).

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity was Moderate, with the largest flare M3.1 peaking at 12/0848 UTC from AR3217. This is a relatively small and compact region which has had magnetic complexity, but has started to show some signs of fading recently. There are currently twelve sunspot groups on the disc, with three further M-class flares and multiple C-class observed in the last 24 hours. These were mostly either from AR3217, but also from near the northwest limb.
No significant CMEs have been detected in available imagery during the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1, continued to be slightly elevated through the period. Wind speeds declined somewhat from around 480 km/s to near 400 km/s. The density remained around average to below average. Total IMF, Bt, was weak at 5nT or below. The north-south component, Bz, varied weakly between +3/-5nT. Phi angle was generally negative (towards the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 remained at background levels. The high energy electron flux (greater than 2MeV) measured by GOES-16 just reached High levels, peaking at 1210 pfu at 12/1840 UTC. The associated 24-hour electron fluence was below Active, reaching 5.3e7 integrated pfu at 13/0000 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is likely to be Moderate, with a slight chance of becoming High with any X-flares. The main regions likely to flare are AR3217 in the southeast and AR3213 in the northwest.

Solar Wind / Geomagnetic Activity: Two filament eruptions occurring on 10th and 11th both gave CMEs which may give glancing impacts at Earth on Days 1 and 2 (13-14 Feb), although this is low confidence. There are no significant coronal holes in the forecast at present, so the forecast for the coming few days is mainly about the possibility of any CME arrivals. In the absence of CME arrivals, wind speeds are most likely to decline to ambient levels. Geomagnetic activity is therefore expected to be mainly Quiet to Unsettled. Perhaps rising to Active to G1/Minor Storm with a slight chance of G2/Moderate Storm on Days 1 and 2 should the above mentioned CMEs arrive, with the risk reducing into Day 3 (15 Feb).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, but with a slight chance of reaching S1 in response to any significant flares. High energy (greater than 2 MeV) electron flux is expected to be on a gradually declining trend. The associated 24 hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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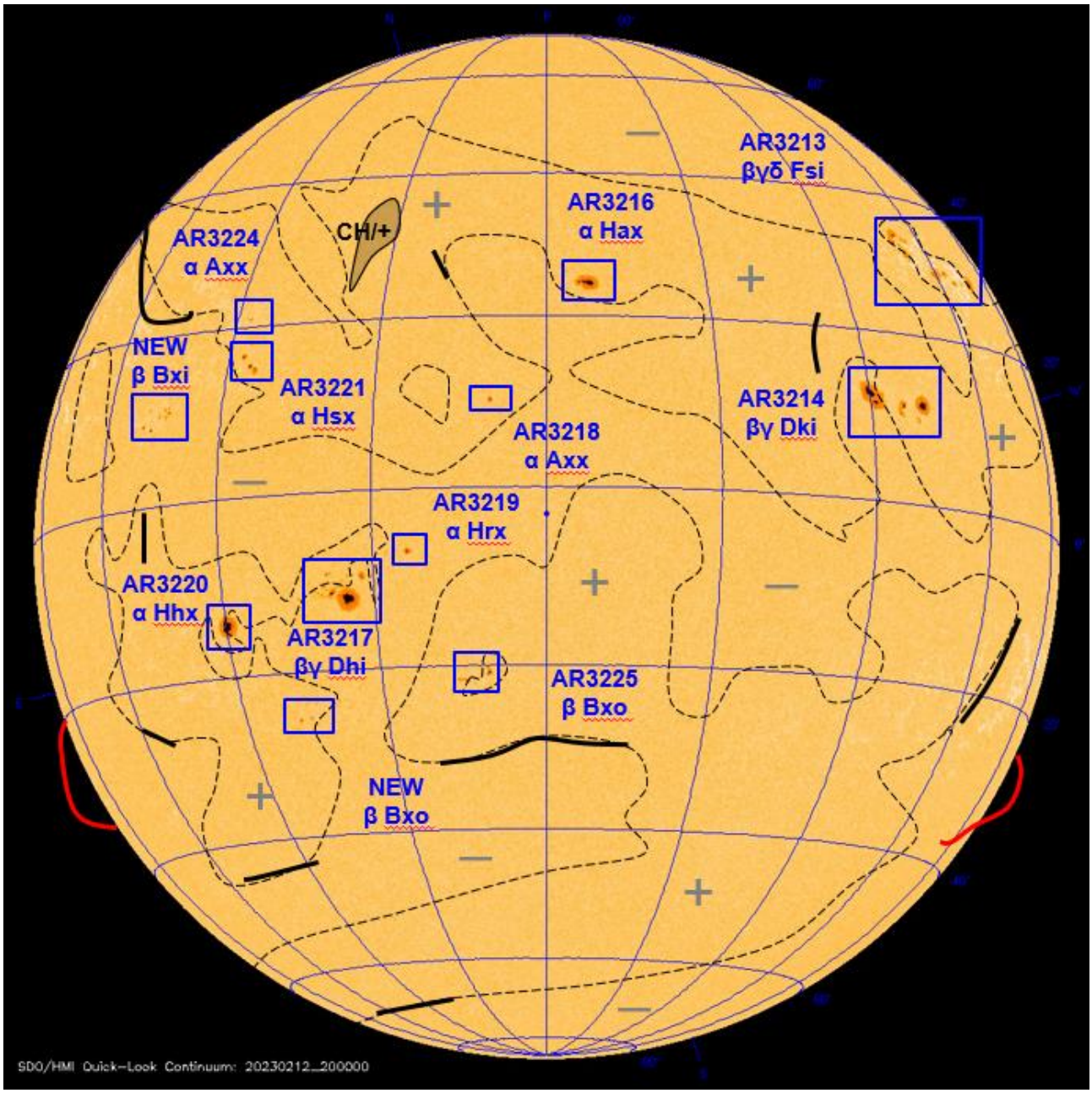
Figure 1. Solar Analysis Valid 12/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption observed in the north centre disc around 11/1050 UTC produced a fast northward directed CME that is expected to largely miss Earth, however glancing effects look to be possible later on Day 1 (13 Feb) or early Day 2 (14 Feb). There is also a further CME which occurred due to a filament lift off in the southwest disc on the 10th. This produced a wide, but slow CME, and is again likely to miss Earth, passing ahead and to the south on Day 2, but may also give a glancing blow.

There are no significant coronal holes in the forecast at present, so the forecast for the coming few days is mainly about the possibility of any CME arrivals. These are low confidence due to being mostly directed away from Earth with the possibility of catching the edge of any CME. In the absence of CME arrivals, wind speeds are most likely to decline to ambient levels. Enlil is suggesting a High Speed Stream arrival on Day 4 (16 Feb), but looking at current AIA-211 imagery this appears unlikely.

Geomagnetic activity is therefore expected to be mainly Quiet to Unsettled. Perhaps rising to Active to G1/Minor Storm with a slight chance of G2/Moderate Storm on Days 1 and 2 should the above mentioned CMEs arrive, with the risk reducing into Day 3 (15 Feb).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	40	10	1
Strong	G3	No	5	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/1257	Partial halo	Filament eruption	NE disc	1700 km/s	14/0100 UTC	Glancing blow possible, low confidence

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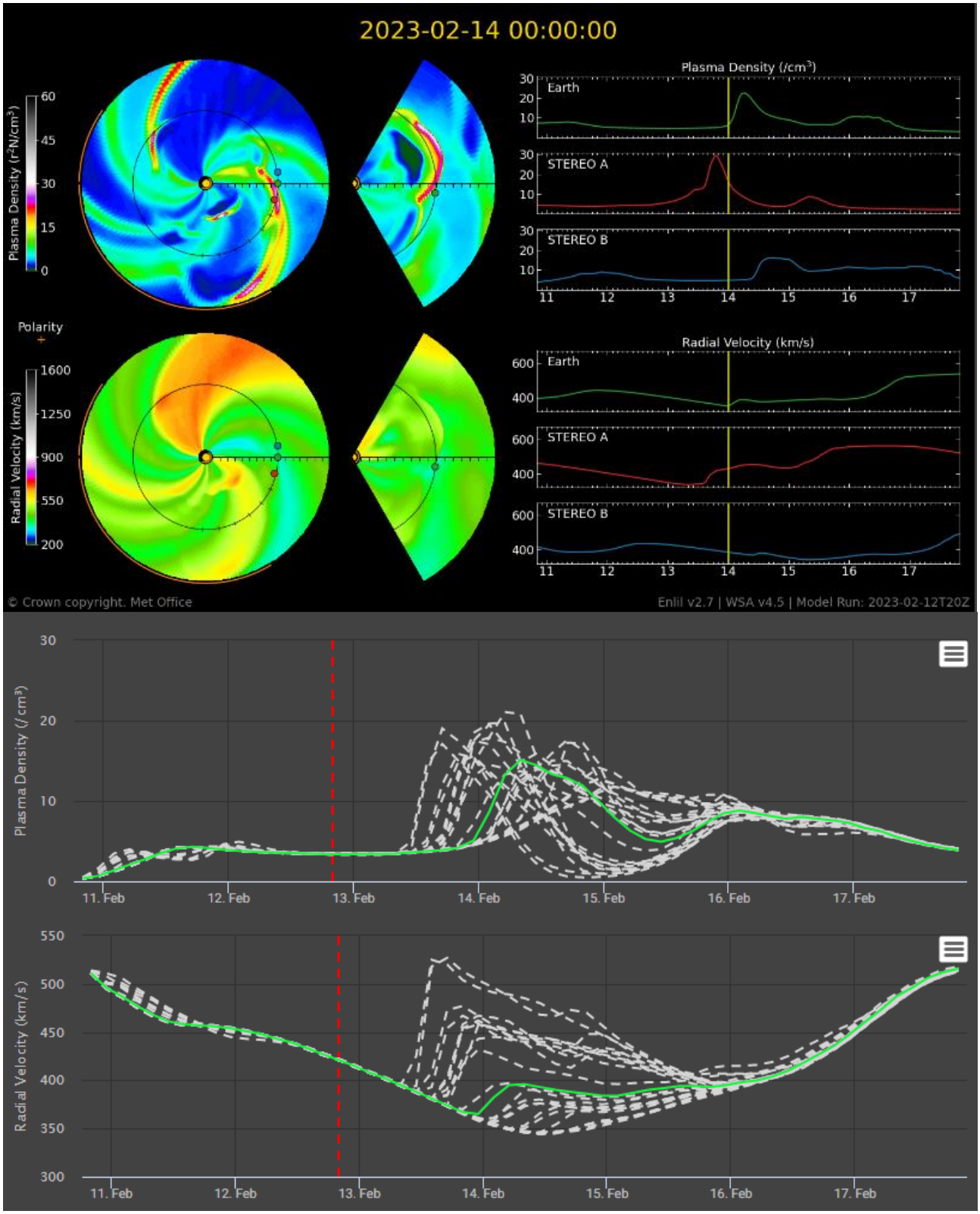
Figure 2: Enlil and ensemble suggesting a CME arrival is possible either later on Day 1 or early on Day 2 (13-14 Feb). The High Speed Stream Enlil is suggesting on Day 4 (16 Feb) seems unlikely.



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Radio Blackouts - X-Ray Flares:
Activity has been Moderate in the last 24 hours, with twelve regions currently on the Earth-facing disc. M-class flares are likely with a slight chance of X-class flares. A slight reduction in risk is indicated as some larger regions start to rotate off the west limb.

The most active region has been AR3217 (now Dhi/Beta-Gamma) in the southeast, which produced an impulsive X1.1 flare on the 11th. This is a modestly sized region, but it appears to have started to fade somewhat and has lost its delta spot. AR3213 (Fsi/Beta-Gamma-Delta) in the northwest has been a source of numerous M-flares. This is getting difficult to assess as it approaches the limb, but still has the potential for further activity. AR3214 (Dki/Beta-Gamma) is also of note, as a moderately sized region in the northwest with some limited magnetic complexity. All other regions are generally smaller and simpler, although M-flares have been observed from regions near the northwest limb.

Far side seismographs are suggesting possible further regions to rotate onto the disc although not for several days. STEREO-A EUV imagery suggests that nothing significant is likely in the next day or so.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	60	50
Very Active	R3 to R5 X Class	No	20	20	15	10

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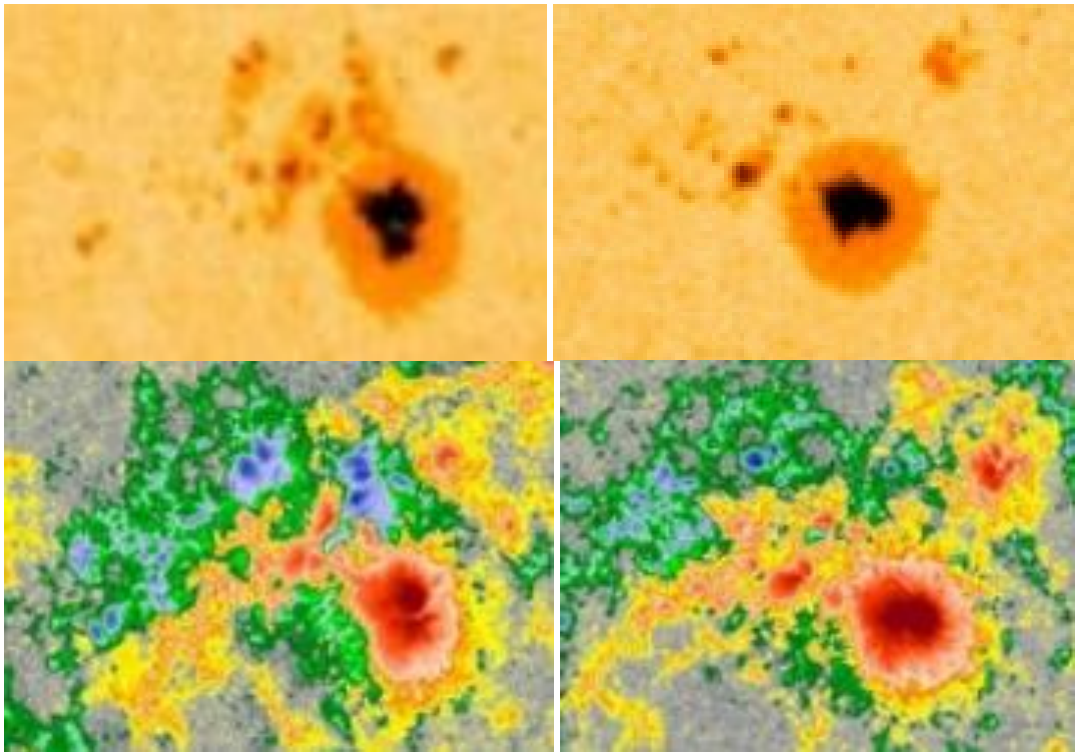
Figure 3: SDO intensitygram and magnetogram of AR3217 at 11/1600 UTC (left) when the X-flare occurred, and at 12/2345 UTC (right) showing the reduction in complexity.



Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux as observed by GOES16 is currently at background levels. No notable high energy proton response has been observed from recent M-flares or the X-flare on the 11th. Any further significant flares may increase count rates, with a slight chance of exceeding the S1 level. AR3213 will rotate off the disc late on Day 2 (14 Feb) with a gradual decline in proton risk thereafter. There remains some proton risk from AR3217 moving into a more favourable location for Earth-directed events, although this region has started to show signs of fading.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	15	15	15	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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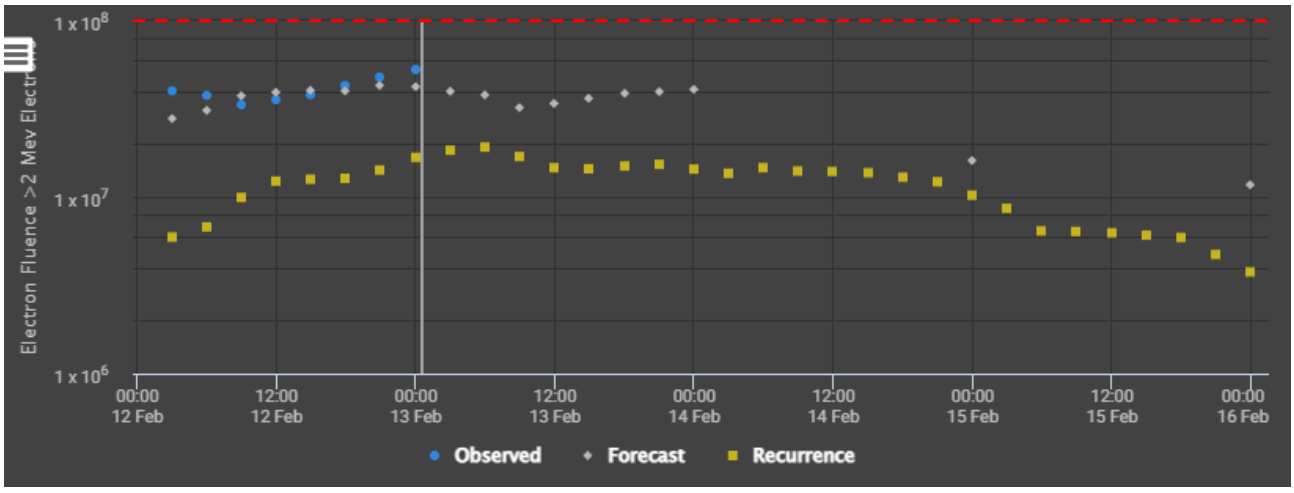
High Energy Electrons Event (≥ 2MeV):
The high energy (greater than 2 MeV) electron flux at GOES-16 is mainly at Moderate levels, but just peaked at High levels during the 12th. With wind speeds likely to decline in the near term, followed by the possibility of one or two CME arrivals, flux is most likely to return to largely background levels. There is some uncertainty if the CME arrivals don't occur, with flux levels perhaps just peaking at High levels and only slowly declining through the next few days.

The associated 24 hour fluence is most likely to remain below the Active level. This is supported by REFM, which is seems to be showing a reasonable trend, although it won't be taking account of any possible CME influence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	5	5	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: MOSWOC REFM showing a below Active trend, which seems reasonable.



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